

Appendix B:  
Tests of the Functional Requirements  
and Macro Control Statements of  
the FEHM Application

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### 1.0 APPENDIX B DESCRIPTION

This appendix contains two tables. Table 1 lists the functional requirements of the FEHM application and, for each requirement, the section in Chapter I that describes that requirement and the sections in Chapter III that describe how that requirement will be tested. Table 2 lists the FEHM macro control statements used by test problems and, for each control statement, the section in the FEHM User's Manual (Zyvoloski et al. 1997b) that describes that macro control statement and the sections in Chapter III that use the control statement in the testing process.

**Table 1. Functional requirements of the FEHM application**

Requirement	Chp. I Section	Tested by (Chp. III section <sup>‡</sup> )
Finite-element coefficient generation	3.1	5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12, 5.13, 5.14, 5.15, 5.16, 5.17
Formulate transient equations	3.2	
Heat-conduction equations	3.2.1	5.2
Heat- and mass-transfer equations	3.2.2	5.3, 5.4, 5.5, 5.7, 5.8, 5.9, 5.10
Noncondensable gas flow equations	3.2.3	5.6, 5.11
Solute-transport equations	3.2.4	5.12, 5.13, 5.14, 5.15, 5.16, 5.17
Particle-tracking module	3.2.5	To be developed
Sources and sinks	3.2.6	5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12, 5.13, 5.14, 5.15, 5.16, 5.17
Apply constitutive relationships	3.3	
Pressure- and temperature-dependent water properties	3.3.1	5.1, 5.3, 5.4, 5.7, 5.8, 5.9, 5.10
Properties of air and air/water vapor mixtures	3.3.2	5.6, 5.11
Equation-of-state models	3.3.3	To be developed
Relative-permeability and capillary-pressure functions	3.3.4	5.5, 5.6, 5.11
Adsorbing solutes	3.3.5	5.12, 5.13, 5.14
Multiple, interacting solutes	3.3.6	5.13, 5.15, 5.16, 5.17
Dual-porosity formulation	3.3.7	5.7
Double-porosity/double-permeability formulation	3.3.8	5.5
Stress-dependent properties	3.3.9	To be developed
Variable thermal conductivity	3.3.10	To be developed

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**Table 1. Functional requirements of the FEHM application (continued)**

Requirement	Chp. I Section	Tested by (Chp. III section <sup>‡</sup> )
Compute solution to transient equations	3.4	5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12, 5.13, 5.14, 5.15, 5.16, 5.17
Implement time-step mechanism	3.4.1	
Solve nonlinear equation set at each time step	3.4.2	
Provide input/output data files	3.5	5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12, 5.13, 5.14, 5.15, 5.16, 5.17
Inputs	3.5.2	
Outputs	3.5.4	
Provide restart capability	3.6	
Write information needed for restart to output file	3.6.1	5.17
Read information needed for restart from restart file	3.6.2	5.10, 5.17
Resume the calculation	3.6.3	5.10, 5.17

<sup>‡</sup>Chapter III sections (Verification and Validation Plan)

- 4.1 Testing of Thermodynamic Functions
- 4.2 Test of Heat Conduction
- 4.3 Test of Temperature in a Wellbore
- 4.4 Test of Pressure Transient Analysis
- 4.5 Test of Infiltration into a One-dimensional, Layered, Unsaturated Medium
- 4.6 Test of Vapor Extraction from an Unsaturated Reservoir
- 4.7 Test of Dual Porosity
- 4.8 Test of Heat and Mass Transfer in Porous Media
- 4.9 Test of Toronyi Two-phase Problem
- 4.10 Test of DOE Code Comparison Project, Problem Five, Case A
- 4.11 Test of Dry-Out of a Partially Saturated Medium
- 4.12 Test of One-dimensional Reactive-solute Transport
- 4.13 Test of Henry's Law Species
- 4.14 Test of Fracture Transport with Matrix Diffusion
- 4.15 Test of the Movement of a Dissolved Mineral Front
- 4.16 Test of Multisolute Transport with Chemical Reaction
- 4.17 Test of Three-dimensional Radionuclide Transport

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**Table 2. FEHM macro control statements used by test problems**

Control statement	User's Manual <sup>#</sup> section	Used by (Chp. III section) (see footnote in Table I)
<b>adif</b>	6.2.3	Not used
<b>airwater</b>	6.2.4	4.6, 4.13, 4.17
<b>alti</b>	6.2.5	Not used
<b>bous</b>	6.2.6	Not used
<b>cap</b>	6.2.7	No longer used, see macro rlp
<b>cond</b>	6.2.8	4.2, 4.3, 4.4, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14, 4.15, 4.16, 4.17
<b>cont</b>	6.2.9	4.2, 4.3, 4.4, 4.5, 4.6, 4.8, 4.9, 4.10, 4.11, 4.13, 4.15
<b>coor</b>	6.2.10	4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14, 4.15, 4.16, 4.17
<b>ctrl</b>	6.2.11	4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14, 4.15, 4.16, 4.17
<b>dof</b>	6.2.12	Not implemented
<b>dpdp</b>	6.2.13	4.5
<b>dual</b>	6.2.14	4.7
<b>elem</b>	6.2.15	4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14, 4.15, 4.16, 4.17
<b>eos</b>	6.2.16	Not used
<b>finv</b>	6.2.17	4.2
<b>flow</b>	6.2.18	4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14, 4.15, 4.16, 4.17
<b>flo2</b>	6.2.19	Not used
<b>fixo</b>	6.2.20	Not used
<b>hflx</b>	6.2.21	4.11
<b>ice</b>	6.2.22	Not used
<b>init</b>	6.2.23	4.2, 4.3, 4.4, 4.7, 4.8, 4.9, 4.10, 4.12, 4.14, 4.15, 4.16, 4.17
<b>iter</b>	6.2.24	4.5, 4.6, 4.7, 4.11, 4.15, 4.16, 4.17
<b>itup</b>	6.2.25	4.11, 4.17
<b>iupk</b>	6.2.26	Not used
<b>ivfc</b>	6.2.27	Not used
<b>mdnode</b>	6.2.28	Not used

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**Table 2. FEHM macro control statements used by test problems (continued)**

Control statement	User's Manual <sup>#</sup> section	Used by (Chp. III section) (see footnote in Table I)
<b>ngas</b>	6.2.29	4.11
<b>nod2</b>	6.2.30	Not used
<b>node</b>	6.2.31	4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14, 4.15, 4.16, 4.17
<b>num</b>	6.2.32	Not implemented
<b>perm</b>	6.2.33	4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14, 4.15, 4.16, 4.17
<b>ppor</b>	6.2.34	Not used
<b>pres</b>	6.2.35	4.5, 4.6, 4.9, 4.11, 4.13, 4.17
<b>ptrk</b>	6.2.36	Not used
<b>renm</b>	6.2.37	Not used
<b>rflx</b>	6.2.38	Not used
<b>rlp</b>	6.2.39	4.5, 4.6, 4.9, 4.10, 4.11, 4.13, 4.17
<b>rock</b>	6.2.40	4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14, 4.15, 4.16, 4.17
<b>rxn</b>	6.2.41	4.13, 4.15, 4.16, 4.17
<b>sol</b>	6.2.42	4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14, 4.15, 4.16, 4.17
<b>solv</b>	6.2.43	Not implemented
<b>stea</b>	6.2.44	Not used
<b>stop</b>	6.2.45	4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14, 4.15, 4.16, 4.17
<b>strs</b>	6.2.46	Not implemented this version of FEHM
<b>text</b>	6.2.47	4.5, 4.17
<b>thic</b>	6.2.48	Not used
<b>time</b>	6.2.49	4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14, 4.15, 4.16, 4.17
<b>trac</b>	6.2.50	4.12, 4.13, 4.14, 4.15, 4.16, 4.17
<b>user</b>	6.2.51	Not used
<b>vcon</b>	6.2.52	Not used
<b>velo</b>	6.2.53	Not used

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**Table 2. FEHM macro control statements used by test problems (continued)**

Control statement	User's Manual <sup>#</sup> section	Used by (Chp. III section) (see footnote in Table I)
<b>wlbr</b>	6.2.54	Not used
<b>zone</b>	6.2.55	4.2, 4.3, 4.5, 4.8, 4.17
<b>#</b>	6.1.1.2	4.5, 4.6, 4.13
<b>file</b>	6.2.2	Not used
<sup>#</sup> Zyvoloski et al. (1997b)		